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# The Goat Dairy Sector in Lebanon

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## Abstract

Goat farming in Lebanon is an ancestral heritage that may disappear by the overflowing of new technologies; its protection is necessary for the preservation of patrimonial traditions that support our regions. Although goat milk is very nutritious and is considered as an acceptable food in several parts of the country, its production and handling remain a major problem limiting its consumption. In the Mediterranean region, and particularly in Lebanon, goat's milk is becoming increasingly important especially because of the popularity of its products (Darfiyeh, Aricheh, Serdale, Shankleesh, Labneh and Kishk). There is a growing interest in the consumption of the aforementioned typical goat products, which is partly due to the uniqueness of such foods. Their market is expanding; therefore, there is an increasing interest in maintaining the authenticity of these typical products. Considering the limited data available and the latest developments, the purpose of the present chapter is to (1) analyse the current situation of the goat dairy sector in Lebanon, (2) shed the light on the particular manufacturing practices and ripening tools used to yield a variety of artisanal products, and (3) review the attempts of valorisation of milk from goats.

**Keywords:** milk production, traditional cheeses, quality aspects, valorisation, goat, Lebanon

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## 1. Introduction

Small ruminants in Lebanon contribute to 25% of milk production. Lebanese goat population counts 403,800 animals [1] of which most of it (96.8%) is Baladi breed.

The goat milk sector in Lebanon continues to improve for many years. Although there were the biological, sanitary and socio-economic constraints, milk production has increased from 21.2 (2008) to 34 (2010) thousand tons [1].

It is mainly intended for direct consumption; but it is also processed only into traditional and local dairy products such as Laban [2], Darfiyeh and Aricheh [3], Serdale [3], Shankleesh [4], Labneh [5] and Kishk [6].

Organoleptic and physico-chemical properties of these artisanal cheeses are defined by natural starters as well as a particular method of production passed from generations to generations. The length of the ripening stage of these cheeses and the specialized containers used to do so, contribute much to their appeal and growing interest.

Goat products have a distinctive and relatively strong flavour compared to cow milk products. Technological parameters influence cheese flavour intensity, since the specialized microorganisms that come into play in characterizing the final product vary in intensity in artisanal products versus mass-produced goat cheese products.

The original products market is expanding not only in Lebanon, but in the whole Mediterranean area as well. The trend towards healthy eating and greener food has led to an increase in the economic importance to goat milk products.

While goat artisanal products are regarded as a nutritious dairy option, parts of the country, which mostly include younger generations, still consider these products as unacceptable for consumption because of its production and handling problem. In fact, data of the Ministry of Public Health in Lebanon showed an increase in the number of reported cases of food poisoning. Some of these cases were related to the consumption of artisanal goat cheeses.

A review of current literature integrated in this chapter provides a unique source of the Lebanese goat sector.

## 2. Goat milk production and yield

According to FAO [7] in 2009, there was 330,000 sheep and 450,000 goats heads in Lebanon. According to the Lebanese Center for Agronomic Research and Studies, the goat milk production in Lebanon accounted for more than EUR 54 million in 2014 with a 76% growth per year and a rising consumer demand.

In fact, sheep and goats have always been an integral part of the rural mosaic in Lebanon. According to a recent study by the FAO [8], goats are mainly referred to as the 'Baladi breed' or 'Shami breed' and sheep are of 'Awassi breed' with local traits.

Both sheep and goats are managed under nomadic and semi-nomadic systems, feeding on natural grasslands, crop remnants, and forest types [8].

The seasonality of dairy production is well defined, due to the scarcity of intensive production systems.

Only a small amount of small ruminant milk production is processed into dairy products such as Kishk or Shankleesh to be sold to consumers or distributors. Producers usually sell the largest part of produced goat milk to manufacturers as whole milk. This account to 87.6% of goat milk and 92.4% sheep milk sold.

According to Khalifat [9], only 10 supermarket chains spread all over the country control over 35% of the Lebanese distribution market, and over 25,000 traditional and modern sales centres also called *Dukkaneh* prevalent in urban areas monopolize the remaining portion of the food distribution market. *Dukkaneh* present a good opportunity for farmers to sell their products beyond their geographic area since they are less demanding when it comes to quality and marketing [10].

Although the production of milk and meat is relatively low, the demand on such products and their by-products remains very high. In fact, the trend in Lebanon is to sell dairy products on the spot in specialized fridges where consumers choose from a variety of native and international variety of cheese or as readily packaged and branded units. Dairy products represent between 12 and 20% of food products total groceries sales, which is a fairly high amount.

This high percentage of dairy sales is in correlation with the major part that dairy occupies in the Lebanese diet with an estimated 189 Kg [11] per capita yearly consumption. Mediterranean diet in general includes dairy product consumption on a regular basis, and can be included in every meal of the day. Correspondingly, Greece for example has 207 Kg per capita and Spain 190 Kg per capita dairy intake. Producers are directly sought after in the weekends and holidays otherwise the sources of purchase are mainly *Dukkaneh* and supermarkets.

According to a previous study by El Balaa et al. [12], small ruminant products are valued by Lebanese consumers, the favoured products being Kishk and Halloumi cheese usually eaten for breakfast, followed by double cream cheese, Akkaoui cheese and Shankleesh. Halloumi, Akkaoui and double cream cheese, they are consumed mostly multiple times per week and the Kishk's frequency of consumption is at least once a week, of course depending on the families' traditions.

In Lebanon, Ministry of Public Health data showed an increase in the number of reported cases of food poisoning, from 43 in 2002 to 373 in 2004. Some of these cases were related to the consumption of homemade cheese.

The local milk production covered in 2005 more than one third of Lebanon consumption needs (in fresh milk equivalent) [13]. The total quantity of locally produced milk increased up to 252,000 tons in 2005 with a 3% increase from 2004. Lebanese cheese imports totalled 32,000 tons in 2002, and full dairy exports amounted to 420 tons in 2002, especially for Akkaoui and Halloumi cheeses.

### 3. Strengths, weaknesses, opportunities and threats

For many small herders, goats are seen as hardier animals than sheep since they can roam farther searching for food and also have a longer milking season [10].

On the other hand, the continuous increase in food poisoning cases reported around Lebanon has highlighted the need to monitor the manufacturing of food products in order to avoid future health hazards [13]. Other constraints mainly relate to the production systems, farm management skills, health of the herds, milk and dairy product quality and their marketing [1].

Although goat milk is very nutritious and is considered as an acceptable food in several parts of the country, its production and handling remains a major problem limiting its consumption. The dispersed nature of production across the diversity of small farms, small volumes and seasonality of milk production, high ambient temperatures in the summer, poor handling systems, lack of cooling facilities in remote areas, lack of well-organized transportation and communication systems all create a considerable challenge to goat milk production [14]. One of the concerns regarding goat milk by the general public is the perception that goat milk or goat milk products have a 'goaty' flavour because of a long history of widespread negative popular misconception [15] against goats. Well-produced and well-handled goat milk is indistinguishable in taste and odour from good quality cow milk [15]. Milk in general and goat milk in particular have their unique characteristic flavour but not unacceptable smell or odour. Proper handling of milking goats and bucks by separation, good management and hygiene can eliminate the poor attitude by consumers towards goat milk [15].

An opportunity relies in mixing pure breed goats to increase milk production in their offspring. Breeding local goats with imported Shami breed from Cyprus can be an innovative strategy. Shami goats are special breed for milk production, producing an average of 4–5 kg/day on average compared to less than 1 kg/day average for Lebanese breeds [10].

Traditional grazing system with no supplements provided to the cattle is being threatened by the declining winter precipitation and the Syrian crisis [10]. The lack of foraging and limited access to traditional grazing is forcing herders to shift into a semi-intensive system, which consists of daily feed supplements during the grazing period.

## 4. Goat products-manufacturing practices and ripening tools

### 4.1. Darfiyeh and Aricheh

Darfiyeh is a semi-hard goat cheese, and the artisanal cheese-making technology originated in Northern Lebanese mountains for many centuries. It is one of the favourite goat cheeses that owe its strong character primarily to its ripening process, using the goatskin. Traditionally, it is manufactured using the raw goat's milk. Cheeses made under these conditions may not have minimal hygiene and sanitary standards needed to obtain consistent product quality [16].

Initially, Ref. [17] concentrated their attention on the hygienic aspects of its manufacture in order to obtain the original cheese with an improved quality. Due to the growing interest in characterization of traditional products, Serhan et al. [18] define the technological features of its production.

#### 4.1.1. Goatskin preparation

Goatskins preparation was reported by Hosri and El Khoury [17]. After slaughtering of the goat, the carcass is fixed by any of its legs, and then the skin is gently removed. The goatskin, preserved in a fresh atmosphere, is subject to an internal salting during one week. After that, the remaining salt is eliminated. The legs are tied, leaving an opening through the neck.

#### 4.1.2. Darfiyeh cheese manufacturing

In the full processing of Darfiyeh, no starter culture is added, nor  $\text{CaCl}_2$  solution. The amount of the microbial rennet powder from *Mucor miehei* (Strength 1:150,000) used is variable, but it guarantees a firm coagulation within 60–90 min. Following coagulation, the curd is compacted for the first drainage of the whey, after which it is pressed by hand into the characteristic shape of a parallelepiped (12, 9 and 9 cm). Subsequently, the whey is boiled and raw goat milk is added to coagulate proteins, in order to get the whey cheese or Aricheh. For ripening, Darfiyeh and whey cheeses are introduced inside the goat's skin, which are stored in a natural cellar at 10–12°C [19] (Figures 1–3).

#### 4.2. Serdale

It is a non-pasteurized goat cheese, known by many names: 'Serdale', 'Jebnet el Fokhara', or 'Ambariss'[3].

The traditional way to prepare is to introduce the raw goat milk in jars that have a 2 inches hole in the base and let it ferment for a year and the procedure consists of adding raw milk and salt; and removing the whey continually.

Till now, the same procedure is applied, but the milk is placed in big plastic gallons, for economic reasons.

According to the flow chart of production below, the production of 'Serdale' is done following these manufacturing steps:

The milk is collected from the farmers in the village as a first step. Jars are prepared by soaking them for 10–15 days in the whey of the milk so that the walls absorb whey well, and washing them with local olive oil soap known as 'Baladi soap'.

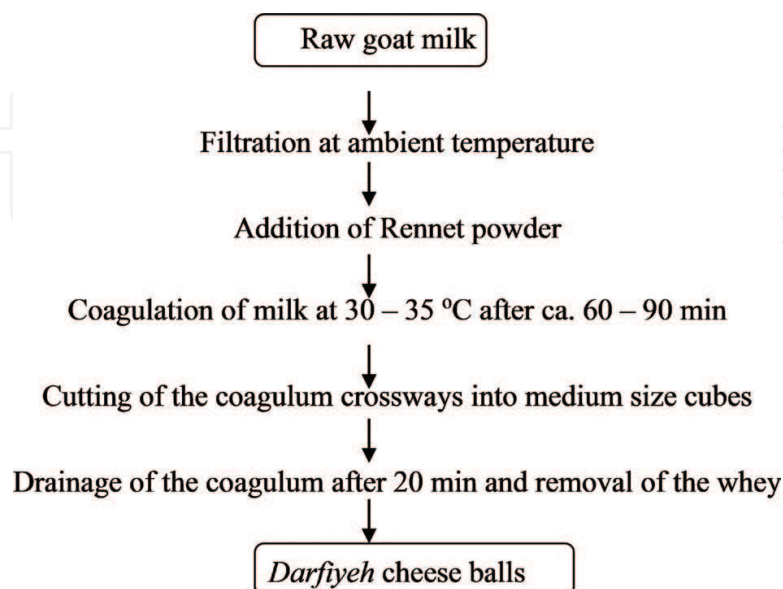


Figure 1. Flow diagram of production of *Darfiyeh* cheese balls [8].



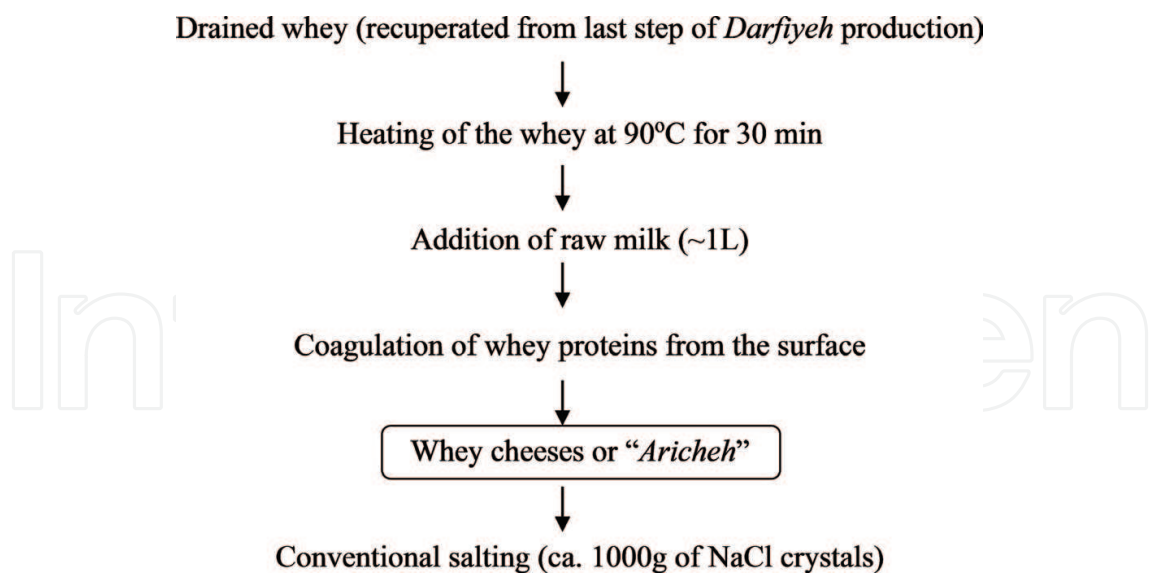


Figure 2. Flow diagram of production of whey cheeses (*Aricheh*) [8].

For every 20 kg of milk, 500 g of salt must be introduced. It is distributed throughout the jar and added in separate amounts periodically. Every time there is appearance of moulds on the surface, it is removed and salt is added again. Total fermentation needs about 15 days to be done. After 15 days, the cap of the jar is removed and the whey is separated from the fermented milk from the whole jar, and raw milk is added again.

This process is repeated several times (about three times) and progressively, until the whey is removed completely by adding raw milk to coagulate the fermented milk.

Finally, the fermented milk is coagulated into small balls and placed in small textile bags to dry to completeness (Figure 4).

In this cheese, the coagulation is only lactic without adding rennet, hence there is a need to identify different types of lactic acid bacteria found in milk and goat cheeses and study their effects on fermentation characteristics and cheese.

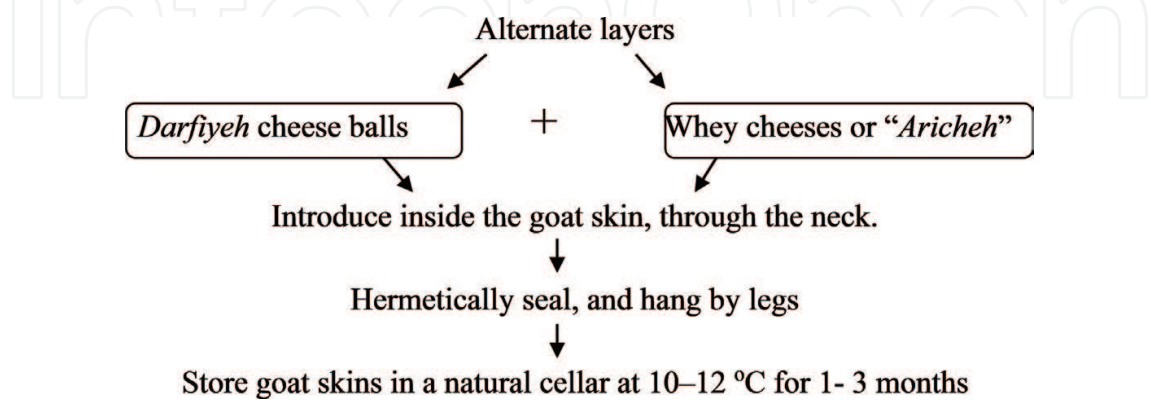
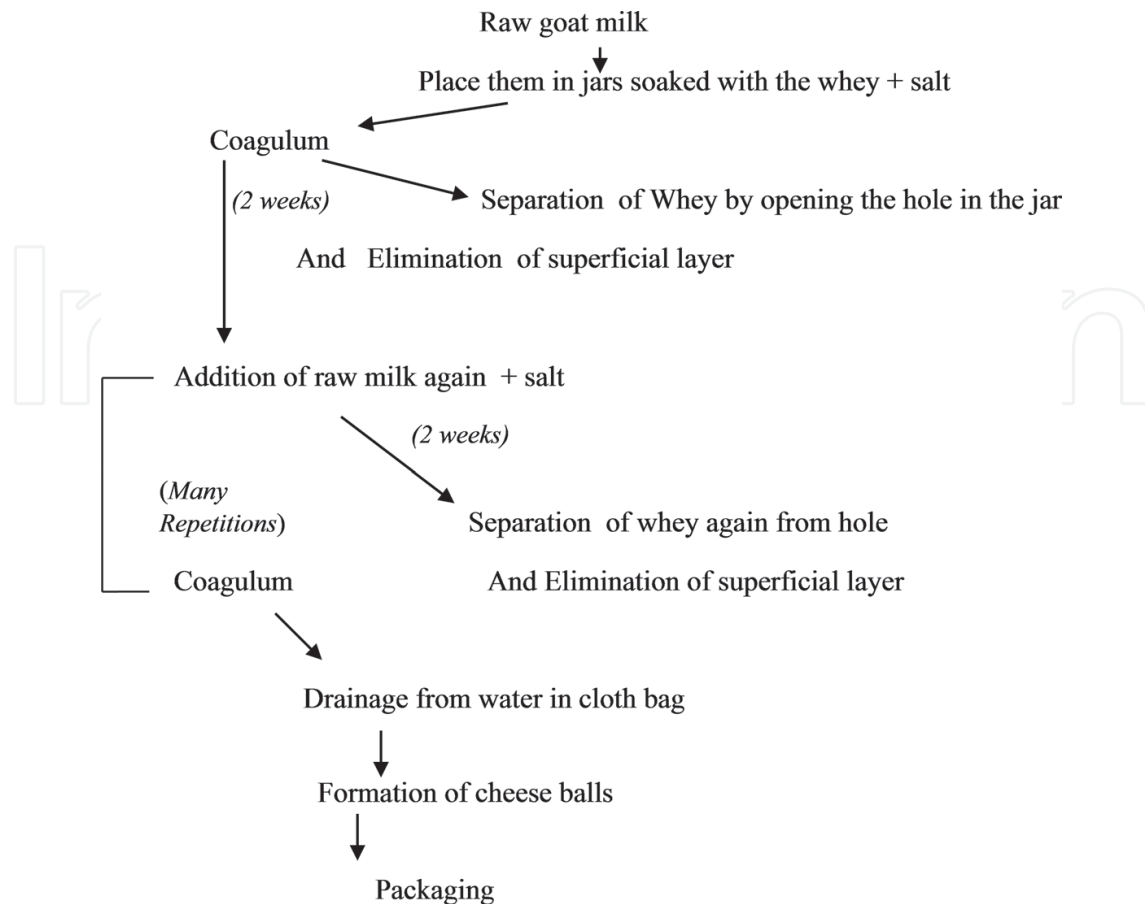


Figure 3. Ripening tools and conditions [8].



**Figure 4.** Flow diagram of production of *Serdale* [5].

### 4.3. Shankleesh

Shankleesh is the only mould-ripened cheese in the Middle East.

Regarding its manufacturing, the precipitate obtained by heating defatted yoghurt is seasoned with salt and powdered with pepper and shaped into balls. The balls are sun-dried, placed in the jars and left to ripen for different intervals of time at ambient temperature.

The mould-covered balls are washed with water, rolled in olive oil and finally covered with powdered thyme (*Thymus vulgaris*). The diversity of microbiota involved during ripening transform the coagulum into a highly flavoured product of unique textural properties.

Furthermore, the low levels of fat (5.6%) [20] coupled with the presumably low water activity of the system and the inhibitory effects of thyme on microbial metabolism confer stability on the product and allow safe storage for long period of time. Although Shankleesh is typically prepared from ewes' milk [20], bovine and caprine Shankleesh products are produced and marketed by local dairy processors, presumably due to seasonal fluctuations in milk supplies.

With reference to the literature available on processing and ripening of different cheese varieties [4, 21, 22], little is known about Shankleesh.



Being coated with thyme, has demonstrated to show inhibitory effects against bacteria. Moreover, its storage in olive oil has made the medium anaerobic thus inhibiting the growth of pathogens. Regardless of the two important advantages, one of the crucial steps in the production of Shankleesh is drying in the open air. At this point, microbial contamination is likely to occur (Zouhairi et al., [23]).

According to Toufeili et al. [4], moderate flavour intensity and well-balanced textural attributes were the salient features of caprine Shankleesh. This was in accordance with the high acceptability scores elicited by the sample, as compared with the bovine and ovine counterparts (Figure 5).

#### 4.4. Labneh

Traditionally, Labneh is a fermented milk product widely appreciated and consumed as an important protein source. Different types of milk can be used in the production of Labneh; namely cow, sheep and goat milks, although cow and, to a lesser extent, goat are more common [2]. It has a short shelf life.

With reference to the Lebanese dairy production, Labneh is made from cow's milk (either full fat or skimmed) or from goat milk in more limited availability. It is produced by a traditional old practice by straining milk set yogurt in cloth bags for 12–18 h at refrigeration temperatures, until the desired total solid level is attained. *Streptococcus thermophilus* and *Lb. delbrueckii* sp. *bulgaricus* are the starter cultures used in its production.

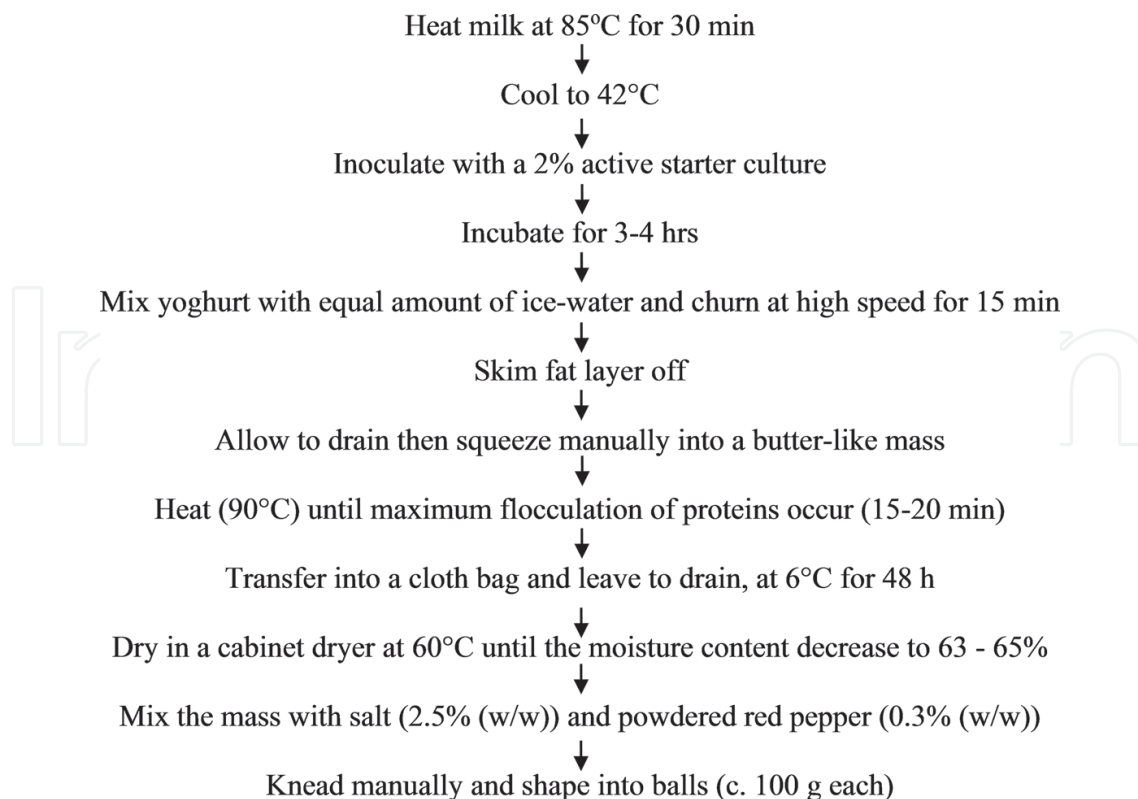


Figure 5. Flow diagram of production of *Shankleesh* [4].

Modern Labneh manufacturing methods used in industrial scale operations include centrifugation, recombination technology and ultrafiltration.

Popularity of Labneh has led to more interest in its structure and rheological properties [24]. Several methodologies have been utilized in the determination of shelf life of Labneh products by monitoring selected microbiological and physicochemical changes during storage [25, 26]. Preference mapping of commercial bovine Labneh products [27] as well as mapping determinants of purchase intent of Labneh [28] were specifically studied in the Lebanese market.

Moreover, several research studies related to the characterization of bovine or caprine Labneh have been reported in the literature. While cow or goat milk cheeses are classically produced either from 100% of each type, investigations were made on cheeses produced from mixtures of cows' and goats' milk, in the aim of producing a better product under quality characteristics. Considering these aspects, [5] have assessed and evaluated the quality parameters and sensory acceptability of Labneh products made with goats' milk, cows' milk and their mixture, and have compared their quality characteristics with those of Labneh products manufactured with the milk from either cows or goats. The development of such products is an interesting opportunity to produce a goat dairy product that is considered satisfactory by consumers (Figure 6).

#### 4.5. Kishk

Kishk is a traditional fermented milk-cereal mixture, widely consumed in Lebanon. It is made from goat's milk, cow's milk or a mixture of both. The product may be manufactured by dairy industries for supermarket retail chains, by granaries or may be made at home.

It is prepared from yogurt, parboiled cracked wheat (Burghol) (ratio of Burghol: yogurt is 1:4) and salt. The ingredients are kneaded daily for up to 6 days at 30–35°C in order to complete the fermentation and conditioning periods. Further to that, the dough is shaped into balls, placed on trays, and dried in the sun for up to 1 week. The dried mixture is milled at granaries. The final dried product is not hygroscopic and can be stored in an open jar for 2 years without any spoilage.

Details of the many different traditional methods employed for the manufacture of Kishk in different countries in the Middle East have been reviewed by several authors. The figure below illustrates the traditional manufacturing stages of Kishk according to Tamime and Robinson [2] (Figure 7).

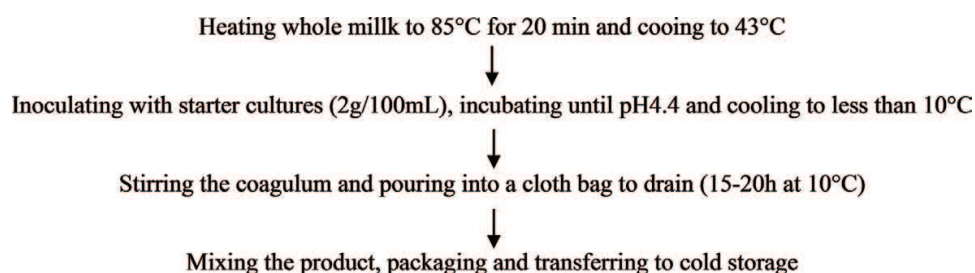


Figure 6. Flow diagram of production of Labneh [6].

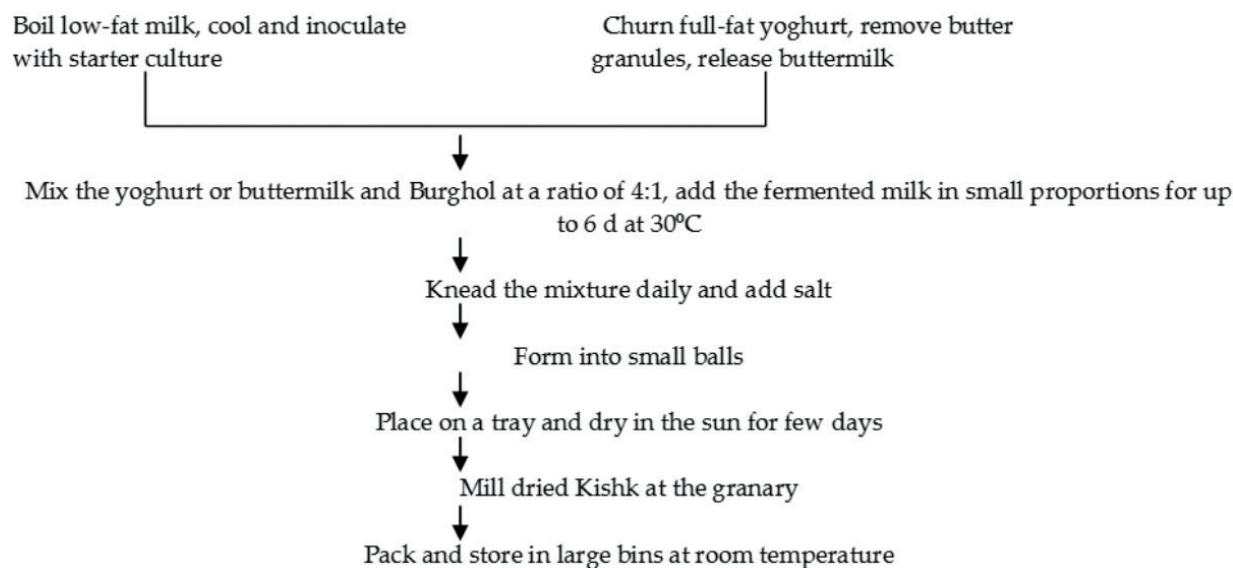


Figure 7. Flow diagram of production of *Kish* (adopted from Tamime and Robinson [2]).

## 5. Valorisation of milk from goats in Lebanon

### 5.1. Prospects for protection of dairy products

Artisanal cheeses refer to cheeses prepared by hand using the unique craftsmanship of the cheese maker. They are usually prepared within family of traditional goat farming in Lebanon, which is an ancestral heritage that could disappear by the overflowing of new technologies, and its protection is necessary for the preservation of patrimonial traditions that support Lebanese regions. These products with all particular practices and customs of production appear as a property bequeathed to the Lebanese community, a legacy. Therefore, it is necessary to improve the craft products, built on their cultural property and to give them a symbolic dimension and a specific attention.

### 5.2. Attempts of safeguarding artisanal products

The technology and composition of most goat cheeses, especially the traditional ones, are not well-documented [29]. The production of traditional goat cheeses is usually carried out on individual farms by shepherds themselves and their families. Most of these cheeses are produced traditionally and manufacturing methods are passed from generation to generation without a technology and regulations standards or pasteurization [30]. Cheeses made under these conditions do not have the minimum hygiene and sanitary guarantees necessary to obtain constant product quality.

The real value of goat cheese is through industrialization under technical and scientific conditions capable of providing products with the indispensable guarantees of quality and constancy [29].

According to the René Moawad Foundation (RMF), Darfiyeh cheese became the first Lebanese artisan produce in the Middle East to receive the 'Presidium' quality level attributed by the

Slow Food Foundation for Biodiversity (SFFD), an international movement founded in 1996 to protect the pleasures of the table from the homogenization of modern fast food.

The RMF had set a program to support the development of small farmers by providing technical assistance for local milk producers so they can improve the quality of Darfiyeh as well as the production conditions, related mainly to hygiene.

### **5.3. Protected designation of origin (PDO)**

In the European Union (EU), protected geographical indication (PGI), protected designation of origin (PDO) and traditional specialty guaranteed (TSG) seals are used to encourage and protect the reputation for quality of agricultural products and food.

According to the Agriculture and Rural Development, European commission, the following EU schemes encourage diverse agricultural production, protect product names from misuse and imitation and help consumers by giving them information concerning the specific character of the products:

‘PDO covers agricultural products and foodstuffs that are produced, processed and prepared in a given geographical area using recognized know-how’.

‘PGI covers agricultural products and foodstuffs closely linked to the geographical area. At least one of the stages of production, processing or preparation takes place in the area’.

‘TSG highlights traditional character, either in the composition or means of production’.

In 2008, a Swiss-Lebanese Project on geographical indication took place. It has a duration of 3 years. The project aimed at defining an adequate system for the protection of geographical indication in Lebanon, through (1) identifying the products originating from a territory or a region, (2) supporting technically the producers in drafting the legal documents for the registration of geographic indications at the Lebanese Ministry of Economy and Trade and (3) providing the necessary information and working with the supply chain actors on agricultural, organizational and economical aspects of geographical indications.

The Lebanese terroir is very rich in traditional food products. According to a UNDP study, 30% of Lebanese can be categorized as poor. About 10% of the people are rural. Agriculture’s share of the gross national product is 6–8% and declining. This decline is negatively affecting the rural poor who still rely on farming for their livelihoods. Subsequently, supporting the implementation of geographical indications, may contribute to enhance the breakdown of traditional food production systems and to reduce the loss of precious indigenous knowledge and the degradation of agro-biodiversity.

## **6. Safety measures**

While it is obvious that the consumer expects the guarantee of high quality, consistent taste, function and the benefits of food safety of cheese, the cheese makers on the other hand want the old style feel to their cheese: all natural, full flavour, and simple packaging. This has

been a major issue in the sales decline of artisanal cheeses. New educated generations are opting for store-bought cheese produced by international manufacturers guarantying safety. However, in the case of artisanal goat cheeses, the desires of both the producer and the consumer can be satisfied if done properly. The key to customer satisfaction depends on focusing on food safety at every step of the cheese manufacturing process without changing the integrity of artisanal cheese-making.

### 6.1. Poor handling procedures

Most of these cheeses are produced traditionally which means manufacturing methods are passed from generation to generation without a standard technology, standard regulations or pasteurization [30]. Cheeses made under these conditions do not have the minimum hygiene and sanitary guarantees necessary to obtain constant product quality.

Raw goat milk does not undergo any pathogen elimination or reduction step, therefore its safety is mainly dependent on the control of the risk factors that may induce contamination during the cheese-making. Minimizing microbiological hazards that may allow the growth of pathogens by maintaining a hygienic handling and controlling appropriate temperature control during storage and distribution.

Only very few farmers have the innovation capacity to follow the correct milking and handling procedures. Goat milk handling is very primitive with almost no cooling devices for the collected milk, and very poor hygienic conditions linked to the cleaning and disinfection of the utensils, which means poor control over zoonotic diseases. This situation is only true with small holders and poor farmers [8]. The few large holdings with large investment and very modern facilities that exist in Lebanon follow the international norms and standards of milking, handling, hygiene and control of quality.

*Brucellosis* is quite frequent with some 13% of the livestock affected in 2002, and a high level of infection of humans. Other sanitary problems are also present and have a serious impact on the livestock population. For example, organisms frequently associated with human illness linked to consumption of dairy products are *Campylobacter* spp., pathogenic *Escherichia coli*, *Listeria monocytogenes*, *Salmonella* spp. and *Staphylococcus aureus*.

In the case of a disease-free goat, the routes in which the disease-causing pathogens enter milk are usually through lack of temperature control, or poor farm and personnel sanitation. A correctly run farm therefore, will have milk that is safe to drink right out of the goat [31].

### 6.2. Good manufacturing practices

The implementation of good manufacturing practices (GMP) during milking and dairy processing in small farms might help them reduce the contamination of dairy products by biological, chemical and physical hazards [32]. GMP defines the series of general measures to be implemented by the food industries to ensure the safety of the process and conformity of food products to precise guidelines.



Moreover, GMP is essential for the implementation of management systems and is the starting point to any food safety system whether Hazard Analysis and Critical Control Point (HACCP), ISO 22000 International Standards Organization, or British Retail Consortium (BRC).

General measures to be implemented by food industries to accomplish with GMP as described by *Codex Alimentarius* include [33]:

- processes necessary for primary production
- design of the premises and equipment
- training, documentation and consumer awareness
- hygiene of the handling personnel
- sanitation and maintenance practices

Although *the Codex Alimentarius* [32, 33] and the Lebanese government may establish general and national guidelines for hygienic practices, the practical implementation to address regulatory requirements procedures adopted consistently by each industry or farm might vary among them. Thus, there is a need to document the practices of each factory in GMP manuals to obtain high quality and safe foods [34].

The implementation of GMPs is a continuous practice based on the management concepts of the plan, do, check and action (PDCA) cycle.

Considering the PDCA cycle, the implementation of GMPs can be divided in four steps: initial diagnosis that includes identifying and addressing safety risks and opportunities, elaboration of road map, addressing of non-conformities and re-evaluation of corrective measures implemented. Initial diagnosis and re-evaluation of corrective measures implemented are usually done by a premises audit visit using a checklist based on the legislation regulating the GMPs in the country. Finally, road maps are generated, based on the previous audit, and corrective measures based on resource priorities and efforts are implemented [34].

Regarding the artisanal cheese-making, implementing the GMPs must be cost effective because of the size of the business is usually of small scale, so several indicators can be used to evaluate the benefits of the implementation of GMPs such as microbiological indicators and perhaps increased appeal to consumers that leads to increased sales.

Typical conditions regarding lack of compliance with GMP in artisanal cheese-making usually include:

Presence of insects and domestic animals as well as unused equipment in the external area, absence of recording thermometers, cracked floor and stone walls, absence of personnel hygiene, food additives in unlabelled containers, use of wooden materials entering into contact with the food, lamps with no protective covers, hoses lying on the floor, personnel not wearing appropriate garments and footwear for working in a food processing plant, and not trained in GMP, and no enforcement of hygienic practices [34].



In addition, production personnel in Lebanon usually gain from past generations of cheese makers, but lack scientific and technological training to realize the consequences of their cheese handling.

Some vital recommendations for the dairy processing industry include [34]:

- a. Build strong relationship with milk producers, in case other than themselves, to improve milk quality and quantity, together, in win-win relationships,
- b. improve compliance with GMPs after being trained of its principles,
- c. train everyone in fundamentals of dairy processing science and technology and
- d. when the proper time arrives, adopt HACCP and ISO.

It is also recommended that the dairy processing industry receives training in novel cheese-making technologies.

The existence of a manual describing how GMPs are accomplished by each processing plant is of foremost importance to ensure their continuous evaluation and improvement by processing plants, governments and partners [31].

Therefore, distributing manuals to all artisanal cheese makers seems a fundamental step in educating them about the minimal procedures to follow to guarantee safe cheese. Arabic printed, and loaded with picture should be the adopted format that enables everyone to understand required guidelines.

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